When time is ripe for that, I venture to hope that it will not be necessary for my very friendly antagonists to lay so much stress upon misrepresentation.

LVI.—*Insect-Larva* (Cecidomyia, *sp.*) *eating Rust on Wheat and Flax.* By N. A. Cobb and A. Sidney Olliff *.

On many specimens of rusted wheat received from various parts of New South Wales we have noticed an orange-coloured larva. Our attention was first called particularly to these larvæ by the fact that they were invariably more common on the rusted plants. The orange colour of the larger of these larvæ would naturally suggest at once some connexion between them and the rust, which is also orange-coloured. This, in fact, had already been the case, one farmer averring most positively that these larvæ were the cause of the rust. This conclusion, founded on colour resemblance alone, could have little, in fact almost no weight, and we were inclined to regard the colour as deceptive, like the red coloration on fence-rails, and felt ourselves fortified in that position by the knowledge that these larvæ were probably *Cecidomyia* larvæ and would very likely be found to live on the juices of the wheat-plant. Later, however, specimens of rusted linseed were received, and on these also the same orange-coloured larvæ were found. We say the same, because on placing them side by side with larvæ from rusted wheat we could detect no difference. If these larvæ fed on the juices of plants, it was somewhat remarkable that the same species should be found on such different plants as wheat and flax. On the other hand, both these plants, though widely different from each other, were attacked by a rust in its *Uredo*-stage, and the *Uredospores of the rust were very similar*. This fact led to the suspicion that the rust-spores might be the food of the larvæ and to the following experiment. A moist chamber was partly filled with water, and in the midst of the water a piece of lead was so arranged as to form a miniature island about one fourth of an inch across. A fresh cutting was then taken from a wheat-leaf in such a manner as to include on its surface a single *Uredo* sorus. This cutting, one eighth of an inch wide and one quarter of an inch long, was placed on the miniature island together with three larvæ of the *Cecidomyia*. The larvæ were taken from a rusted linseed plant, and pains

* From an advance proof, communicated by the Authors, from the 'Agricultural Gazette of New South Wales,' vol. ii. part 2. By authority. Sydney, 1891.

was taken to place them on the lead and not on the wheat-cutting. Finally a glass cover was laid over the chamber, to prevent evaporation, and thus keep the wheat-cutting from withering. The object of the experiment was to ascertain how these little larvæ would behave towards the wheat-cutting and the rust-pustule on it. After about an hour, during which time no note was taken of the movements of the larvæ, the chamber and contents were placed under the microscope, when all the larvæ were found at the rust-pustule, and one of them was unmistakably feeding. The larva took one spore after another, and made very short work of each. It remained uncertain whether other food was taken, but it seemed very improbable. The operations were distinctly seen.

These interesting facts give rise to the following deductions:—In the first place it could hardly have been accidental that all three of the larvæ after one hour had found their way to the single accessible rust-pustule, which could not have been above half a millimetre in diameter. Their arrangement (one on top of another) was exactly that common to greedily feeding animals. It is therefore probable that the two larvæ which were not observed to actively feed had already satisfied their hunger.

Secondly, it is established that these larvæ will, at least under some circumstances, feed on the rust-fungus, apparently in preference to perfectly fresh tissues of the wheat-leaf.

Again, it must be borne in mind that the larvæ experimented with were taken from a rusted linseed plant. This goes to show that it is the rust that is sought rather than the juices of any particular plant.

Of course these experiments should be repeated and extended; but no opportunity has occurred to us for this, and it is not likely that they can be repeated until next season.

We shall endeavour to breed these larvæ, so as to obtain the perfect insect. Observations will be made on its habits, with the object of ascertaining more exactly the relations of the insect to rust. If it is found to live exclusively on the rust-fungus, then, so far at least, it is beneficial to the wheat-grower. If, however, it should be found in its wanderings to carry the rust-spores about on the surface of its body, and thus distribute the fungus, it would in that respect be harmful. We have no evidence of this, their bodies having been in all cases found clean and free from adhering spores; however, not very much attention has yet been given to this latter matter.

An idea has occurred to us almost purely speculative, but

which we give for what it is worth. It is well known that the Hessian fly, which also belongs to the genus *Cecidomyia*, is the worst enemy to the wheat-crop in the United States, while rust does much less damage there than in Australia. In this country the reverse is true; rust is the great evil, while the Hessian fly is at present unknown *. Have these facts any relation to each other? Taken in the light of the above observations on a species of *Cecidomyia* feeding on rust, it may not seem too fine-spun a speculation if we suggest that there may be a connexion. Let us suppose the larvæ of the Hessian fly to prefer rust as food if available, but to fall back on the juices of the wheat-plant when the rust gives out. This might account for the comparative rarity of rust where the Hessian fly is abundant, which is the case in America. All this is from the mountain-top of speculation. If, however, it should lead to an excursion into the valley of observation and experiment, some good may come of it.

Not that we would suggest the introduction of the Hessian fly for the sake of getting rid of the rust, even if the above suggestion should turn out to be well founded. We would, however, call attention to the need of further observations on the relations between fungi on the one hand and insects and mites on the other. It has already often been noticed that certain fungi are commonly accompanied by certain insects and mites. What, if any, is the relationship in these cases?

It remains to describe these larvæ in such terms as to make them recognizable to other observers. In this we are aided by the four accompanying illustrations.

The larva undoubtedly belongs to the family Cecidomyidæ, and in many respects, if the published figures are to be trusted, it comes very close to the larva of the true Hessian fly (*Cecidomyia destructor*, Say). It is composed of twelve segments, exclusive of the head and the so-called "supplementary segment," and possesses the characteristic two-jointed antennæ as well as the curious thoracic appendage called the "breast-bone" or "anchor-process." The head is retractile and is capable of being withdrawn within the first thoracic segment; and in every other structural detail it coincides with what we know of the larvæ of the genus *Cecidomyia*. An examination of these specimens clearly shows that the "supplementary segment" pertains to the head and not to the thorax. No further proof of this assertion is required than the statement that the eye-spots are situated in this additional somite. In the illustration the eye-spots appear to be within the ante-

* The pest has, however, been recorded from the Wellington district, New Zealand, where it is said to have caused much damage.

rior margin of the first thoracic segment; but this is not really the case. The appearance is deceptive, and is merely due to the fact that the "supplementary segment," or, more correctly, the hinder division of the head, is partly withdrawn into the first thoracic segment. Our larva has the protrusile labium which is common to all the species of the family, and the anal segment of the body is provided with a retractile organ, which probably assists the larva in locomotion. We did not observe that this particular larva possessed the power of jumping, as some of its allies are said to do. When young the specimens were dull white in colour, but afterwards they turned to a bright orange-yellow. In the latter state they measured $1\frac{3}{4}$ millimetres; but perhaps they were scarcely full-grown.

In explaining, more particular reference is made to the side or profile view (fig. 1). This figure shows the head and part of the thorax of a young larva. The thoracic rings bear rows of bristles, so that the beginning of the thorax is readily made out. In the illustration the head is not fully extended; therefore the eyes, two collections of dark-coloured granules just in front of the brain, appear as if situated in the first segment of the thorax. The downward-pointing nozzle is seen in front, and on the forehead above it two finger-shaped feelers or antennæ. The jaw-muscles, situated inside the forehead just behind the antennæ, are attached to the mouth-parts below and to the wall of the head above. The most conspicuous feature of the head, however, is a pair of dark-coloured three-pronged pieces of horn (of which only the nearer one is shown in the large profile view), so arranged as to form a supporting framework for the attachment of muscles, one prong extending forwards to near the mouth-parts, another extending backward and thinning out in the region of

Fig. 1.

Head and Prothorax of young *Cecidomyia* Larva (profile).

Above a single rust-spore proportionately enlarged.

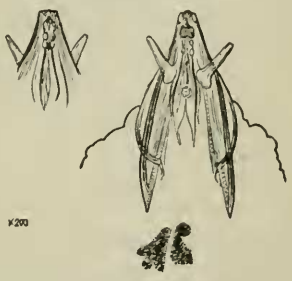
the eyes, and a short third passing upward and inward and articulating with a long slender piece of horn whose front attachment is near that of the jaw-muscles on the forehead. This framework, by its strength and elasticity, preserves the form of the head and serves at the same time for the attachment of muscles mostly retractive. Thus the free ends of the hindmost prongs serve for the attachment of at least three pairs of muscles:—(1) fan-shaped muscles, passing downward and serving to lift the head; (2) narrow muscles, passing forward and serving to retract the front portion of the head; (3) narrow muscles, passing backward and aiding to retract the whole head, an operation in which they are assisted by muscles attached anteriorly to the short prongs of the framework and posteriorly to the upper part of the body-wall of the thorax.

Fig. 2.

Breast-bone or Anchor Process.

The most striking feature in the thorax is the peculiar "breast-bone" (fig. 2) found on the lower part. Seen from the side this organ seems to be of nearly uniform size throughout and to be forked in front. Seen from below, however, it is found to be wider in front, where it ends in a distinct and somewhat heart-shaped head. This breast-bone stiffens the thorax, and very likely serves other purposes. Fig. 1 also shows the anterior thoracic stoma; the oval above and to the right shows the relative size of a rust-spore (*Puccinia rubigo-vera*).

Fig. 3.



Head, showing Mouth-parts. (Dorsal and ventral views.)

Department of Agriculture,
Sydney, N. S. W.

Note.—Since the above was written we have seen larvæ on plum-leaves feeding on the spores of *Puccinia pruni*, and others on the rusted leaves of *Bidens pilosus*, which appear upon careful microscopical examination to be identical with those here described.